

A GRAPHICAL USER INTERFACE HAVING AN ATTACHED TOOLBAR FOR DRAG AND DROP EDITING IN DETAIL-IN-CONTEXT LENS PRESENTATIONS

This application claims priority from Canadian Patent Application No. 2,393,887 filed July 17, 2002, the disclosure of which is incorporated herein by reference.

5 FIELD OF THE INVENTION

This invention relates to the field of computer graphics processing, and more specifically, to a method and system for performing accurate drag and drop ("DAD") operations on digital images using detail-in-context lenses and a detail-in-context graphical user interface ("GUI") having an attached toolbar.

10 BACKGROUND OF THE INVENTION

Most modern computer software employs a graphical user interface ("GUI") to convey information to and receive commands from users. A graphical user interface relies on a variety of GUI objects or controls, including icons, toolbars, drop-down menus, text, dialog boxes, buttons, and the like. In such GUI systems, toolbars provide an effective way to display numerous computer commands or controls. Toolbars usually include buttons, which are arranged in one or more rows or columns. Each button is associated with a command, and is identified by an icon that represents or depicts that command. For example, the "print" command may be invoked by clicking on a button whose icon depicts a printer. Advantageously, a user can invoke commands on the toolbar by clicking once on the associated button. In addition to buttons, toolbars can also include other interactive controls, such as text boxes, combo boxes, etc. Some toolbars can be turned on or off, and can be oriented horizontally or vertically. Although most toolbars are visually attached to a window, some may float above a window. In some programs that employ toolbars, the toolbars can be modified by adding or deleting controls, or by changing the function associated with a control. This allows the user to customize a toolbar so that the toolbar provides convenient access to the commands that are most frequently used by the user. In addition, these programs support multiple toolbars that can be turned on and off, thereby providing the user with the option of viewing two or more toolbars simultaneously. In some prior art systems, the process of customizing or manipulating toolbars requires use of a dialog box that displays a list

of commands available for the toolbar. The dialog box also can display a list of available toolbars that can be displayed for the application. The user can then customize the toolbar by selecting which controls the user wants displayed.

5 Now, a user typically interacts with a GUI by using a pointing device (e.g., a mouse) to position a pointer or cursor over an object and "clicking" on the object. For example, a drag and drop ("DAD") operation may be initiated by selection from a toolbar or by selecting an object within a digital image. In a typical DAD operation, a pointing device is used to select an object (e.g. text, icons, graphical objects, etc.) under a cursor and then "drag" the selected object to a different location or orientation on a display screen. The user may then "drop" or release the object at a
10 desired new location or orientation indicated by the position of the cursor. Selecting is usually a first step, generally initiated by holding down a button associated with the pointing device (e.g., a mouse button) and gesturing with the pointing device to indicate the bounds of the object to be selected (as in text selection), or simply by "clicking" on the object under the cursor (as in graphical image or icon selection). Selection is typically indicated by a change in the visual
15 display of the selected object (e.g., by using reverse video, displaying a frame around the object, displaying selection handles around the object, etc.). Dragging is usually a separate step distinct from selection, and is usually initiated by clicking on a selected object and holding a control button down (e.g., holding a mouse button in a depressed state). The object is then dragged while holding the control button. However, in some applications, initiating dragging also selects the
20 object under the cursor. The operation is completed by dropping the selected object.

For many applications, a drag operation may be used to initiate several possible functions relative to an object. For example, in a text application, a selected section of text may be moved or copied by a drag operation. Normally, if multiple functions are possible, one such function (e.g., moving) is a "default" function of a drag operation, while the other functions must be
25 selected by some combination of modifiers (e.g., pressing keys like "SHIFT", "ALT", and "CTRL") while operating the pointing device. In some applications, after completing the drag operation, a menu automatically pops up to allow a user to choose a specific "drop" function. In other applications, such as that described in U.S. Patent No. 6,246,411 to Strauss, a user may select among multiple functions during a drag operation using a toolbar, thus allowing the user to
30 change a gesture after it has begun.

One problem with present DAD methods such as that described by Strauss is that a user may have difficulty selecting the object to be dragged or the location where that object is to be dropped. Thus, a user may have to repeat the DAD operation several times in order to achieve the desired result. In other words, while present DAD methods may provide a user with a desired
5 image after several iterations, these methods do not provide for the accurate selection and positioning of the desired object at the outset. Thus, and especially for large image presentations such as digital maps, a user may have to repeat the DAD operation several times in order to accurately select or position the desired object. For example, while a user may use well-known "panning" and "zooming" tools to view a desired object in an original image in order to
10 reposition that object, in doing so, the relative location of the new position for that object may be lost to the user or the user may find it difficult to determine what portion of the original image is being observed. Thus, while the user may have gained a detailed view of a region of the original image that is of interest, the user may lose sight of the context within which that region is positioned. This is an example of what is often referred to as the "screen real estate problem".

15 A need therefore exists for an improved method and system for performing accurate drag and drop operations on digital images. Consequently, it is an object of the present invention to obviate or mitigate at least some of the above mentioned disadvantages.

SUMMARY OF THE INVENTION

According to one aspect of the invention, there is provided a method for positioning a selected
20 object in a computer generated original image on a display, comprising the steps of: distorting the original image to produce a distorted region for the object; dragging the object and the distorted region to a desired position; and, dropping the object at the desired position, whereby the object is accurately positioned.

Preferably, the step of distorting further includes the steps of: creating a lens surface for the
25 distorted region; and, transforming the original image by applying a distortion function defining the lens surface to the original image.

Preferably, the step of creating further includes the step of displaying a GUI over the distorted region for adjusting the lens surface.

Preferably, the lens surface includes a focal region and a base region and the GUI includes: a slide bar icon for adjusting a magnification for the lens surface; a slide bar icon for adjusting a degree of scooping for the lens surface; a bounding rectangle icon with at least one handle icon
5 for adjusting a size and a shape for the focal region; a bounding rectangle icon with at least one handle icon for adjusting a size and a shape for the base region; a move icon for adjusting a location for the lens surface within the original image; a pickup icon for adjusting a location for the base region within the original image; and, a fold icon for adjusting a location for the focal region relative to the base region.

- 10 Preferably, the GUI further includes an attached toolbar and the toolbar includes function selection icons and/or function status icons.

Preferably, the steps of dragging, dropping, and adjusting are performed by moving a cursor on the display with a pointing device; the cursor is an icon; and, the pointing device is a mouse.

Preferably, the distorted region is on or overlaps the object.

- 15 Preferably, the object is a selection from the original image, an icon, a text selection, or a selection from an external source. Preferably, the external source is an image other than the original image.

Preferably, the step of dragging further includes the step of cutting the object from the original image.

- 20 Preferably, the step of dropping further includes the step of pasting the object into the original image.

Preferably, the display is a touchscreen display of a photograph processing workstation or kiosk.

Preferably, the toolbar includes an icon representing the object.

- 25 Preferably, the toolbar is transparent, thereby allowing observation of the original image through the toolbar. The toolbar may also be translucent.

According to another aspect of the invention, there is provided a method for manipulating a presentation of a region-of-interest within visual information on a display screen of a computer, the region-of-interest including a focal region and a base region, the method comprising the steps of: displaying a toolbar over the region-of-interest for selecting at least one parameter for transforming at least one of the region-of-interest, the focal region, and the base region; selecting the at least one parameter from the toolbar with a pointing device; transforming the visual information in accordance with a predetermined distortion function and the at least one parameter to produce transformed visual information; and, displaying the transformed visual information on the display screen.

Preferably, the at least one parameter includes: a magnification for the region-of-interest; a size for the focal region; a size for the base region; a shape for the focal region; a shape for the base region; a location for the region-of-interest within the visual information; a location for the base region within the visual information; a location for the focal region relative to the base region; and, a degree of scooping between the focal and base regions.

Preferably, the toolbar includes at least one lens icon for selecting the at least one parameter. Preferably, the at least one lens icon represents the transformed visual information. Preferably, the at least one lens icon includes a pyramidal lens icon, a circular based lens icon, and a circular focused lens icon.

Preferably, the toolbar includes: a pointer icon for selecting points in the visual information; a hand tool icon for selecting a view area in the visual information; a zoom tool icon for zooming into or away from the region-of-interest; a measuring tool icon for initiating a measurement function; a help tool icon for initiating a user help function; a continuation arrow icon for indicating and scrolling additional toolbar icons into view; a delete icon for deleting the presentation from the transformed visual information; a printer icon for selecting and indicating a status of a print function; a floppy disk icon for selecting and indicating a status of a save function; a redo icon for selecting a redo function; an undo icon for selecting an undo function; a resize base icon for selecting a predefined base region resizing function; and, a resize focus icon for selecting a predefined focal region resizing function.

Preferably, the toolbar is a horizontal or vertical toolbar. Preferably, the toolbar is distributed over boundaries of the base and focal regions.

Advantageously, since the magnification at the focus of the distorted region or lens is greater than that at the base of the lens, dragging the lens with the selected object makes it easier for a user to align a point on the selected object with a point at the new location for the object in the digital image or presentation. As the lens with its selected object moves to the new location, the region around the new location is magnified to the same high resolution. As a result, the accuracy of aligning the point on the selected object to a desired point at the new location is improved. In addition, the user is assisted throughout this drag and drop operation by being able to observe the detail in the lens focus in the context of the surrounding presentation.

In addition, by attaching the toolbar to the lens GUI, the controls available through the toolbar are made more easily accessible to a user. As the lens and GUI move, the toolbar moves with them allowing the user easy access to alternate lens applications as the user homes-in on an object or region-of-interest in a presentation. In this way, if the user decides to change lens applications, the toolbar is exactly where the user requires it, that is, near the lens.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention may best be understood by referring to the following description and accompanying drawings. In the description and drawings, like numerals refer to like structures or processes. In the drawings:

FIG. 1 is a graphical representation of the geometry for constructing a three-dimensional (3D) perspective viewing frustum, relative to an x, y, z coordinate system, in accordance with known elastic presentation space graphics technology;

FIG. 2 is a graphical representation of the geometry of a presentation in accordance with known elastic presentation space graphics technology;

FIG. 3 is a block diagram illustrating a data processing system adapted for implementing an embodiment of the invention;

FIG. 4 a partial screen capture illustrating a GUI having lens control elements for user interaction with detail-in-context data presentations in accordance with an embodiment of the invention;

FIG. 5 is a screen capture illustrating a GUI having lens control elements and an attached horizontal toolbar for user interaction with a detail-in-context data presentation in accordance
5 with an embodiment of the invention;

FIG. 6 is a screen capture illustrating a GUI having lens control elements and an attached vertical toolbar for user interaction with a detail-in-context data presentation in accordance with an embodiment of the invention;

FIG. 7 is a screen capture illustrating a GUI having lens control elements and an attached corner
10 toolbar for user interaction with a detail-in-context data presentation in accordance with an embodiment of the invention;

FIG. 8 is a screen capture illustrating a GUI having toolbar icons placed over base and focus
resize handle icons for user interaction with a detail-in-context data presentation in accordance
with an embodiment of the invention;

FIG. 9 is a screen capture illustrating a selected object in an original image in accordance with an
15 embodiment of the invention;

FIG. 10 is a screen capture illustrating the attachment of a lens to a selected object to produce a
detail-in-context presentation in accordance with an embodiment of the invention;

FIG. 11 is a screen capture illustrating a drop and drag operation for a detail-in-context
20 presentation in accordance with an embodiment of the invention; and,

FIG. 12 is a flow chart illustrating a method for positioning a selected object in a computer
generated original image on a display in accordance with an embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the following description, numerous specific details are set forth to provide a thorough
25 understanding of the invention. However, it is understood that the invention may be practiced

without these specific details. In other instances, well-known software, circuits, structures and techniques have not been described or shown in detail in order not to obscure the invention. The term "data processing system" is used herein to refer to any machine for processing data, including the computer systems and network arrangements described herein.

- 5 The "screen real estate problem" mentioned above generally arises whenever large amounts of information are to be displayed on a display screen of limited size. As discussed, well-known tools to address this problem include panning and zooming. While these tools are suitable for a large number of visual display applications, they become less effective where sections of the visual information are spatially related, such as in maps, three-dimensional representations, and
10 newspapers, for example. In this type of information display, panning and zooming are not as effective as much of the context of the panned or zoomed display may be hidden.

A recent solution to this problem is the application of "detail-in-context" presentation techniques. Detail-in-context is the magnification of a particular region-of-interest (the "focal region" or "detail") in a data presentation while preserving visibility of the surrounding
15 information (the "context"). This technique has applicability to the display of large surface area media (e.g. digital maps) on computer screens of variable size including graphics workstations, laptop computers, personal digital assistants ("PDAs"), and cell phones.

In the detail-in-context discourse, differentiation is often made between the terms "representation" and "presentation". A representation is a formal system, or mapping, for
20 specifying raw information or data that is stored in a computer or data processing system. For example, a digital map of a city is a representation of raw data including street names and the relative geographic location of streets and utilities. Such a representation may be displayed visually on a computer screen or printed on paper. On the other hand, a presentation is a spatial organization of a given representation that is appropriate for the task at hand. Thus, a
25 presentation of a representation organizes such things as the point of view and the relative emphasis of different parts or regions of the representation. For example, a digital map of a city may be presented with a region magnified to reveal street names.

In general, a detail-in-context presentation may be considered as a distorted view (or distortion) of a portion of the original representation where the distortion is the result of the application of a

“lens” like distortion function to the original representation. A detailed review of various detail-in-context presentation techniques such as “Elastic Presentation Space” (“EPS”) (or “Pliable Display Technology” (“PDT”)) may be found in a publication by Marianne S. T. Carpendale, entitled “A Framework for Elastic Presentation Space” (Carpendale, Marianne S. T., *A Framework for Elastic Presentation Space* (Burnaby, British Columbia: Simon Fraser University, 1999)), and incorporated herein by reference.

In general, detail-in-context data presentations are characterized by magnification of areas of an image where detail is desired, in combination with compression of a restricted range of areas of the remaining information (i.e. the context), the result typically giving the appearance of a lens having been applied to the display surface. Using the techniques described by Carpendale, points in a representation are displaced in three dimensions and a perspective projection is used to display the points on a two-dimensional presentation display. Thus, when a lens is applied to a two-dimensional continuous surface representation, for example, the resulting presentation appears to be three-dimensional. In other words, the lens transformation appears to have stretched the continuous surface in a third dimension. In EPS graphics technology, a two-dimensional visual representation is placed onto a surface; this surface is placed in three-dimensional space; the surface, containing the representation, is viewed through perspective projection; and the surface is manipulated to effect the reorganization of image details. The presentation transformation is separated into two steps: surface manipulation or distortion and perspective projection.

FIG. 1 is a graphical representation **100** of the geometry for constructing a three-dimensional (“3D”) perspective viewing frustum **220**, relative to an x, y, z coordinate system, in accordance with known elastic presentation space (EPS) graphics technology. In EPS technology, detail-in-context views of two-dimensional (“2D”) visual representations are created with sight-line aligned distortions of a 2D information presentation surface within a 3D perspective viewing frustum **220**. In EPS, magnification of regions of interest and the accompanying compression of the contextual region to accommodate this change in scale are produced by the movement of regions of the surface towards the viewpoint (“VP”) **240** located at the apex of the pyramidal shape **220** containing the frustum. The process of projecting these transformed layouts via a perspective projection results in a new 2D layout which includes the zoomed and compressed

regions. The use of the third dimension and perspective distortion to provide magnification in EPS provides a meaningful metaphor for the process of distorting the information presentation surface. The 3D manipulation of the information presentation surface in such a system is an intermediate step in the process of creating a new 2D layout of the information.

5 FIG. 2 is a graphical representation **200** of the geometry of a presentation in accordance with known EPS graphics technology. EPS graphics technology employs viewer-aligned perspective projections to produce detail-in-context presentations in a reference view plane **201** which may be viewed on a display. Undistorted 2D data points are located in a basal plane **210** of a 3D perspective viewing volume or frustum **220** which is defined by extreme rays **221** and **222** and
10 the basal plane **210**. The VP **240** is generally located above the centre point of the basal plane **210** and reference view plane ("RVP") **201**. Points in the basal plane **210** are displaced upward onto a distorted surface **230** which is defined by a general 3D distortion function (i.e. a detail-in-context distortion basis function). The direction of the viewer-aligned perspective projection corresponding to the distorted surface **230** is indicated by the line FPo - FP **231** drawn from a
15 point FPo **232** in the basal plane **210** through the point FP **233** which corresponds to the focus or focal region or focal point of the distorted surface **230**.

EPS is applicable to multidimensional data and is well suited to implementation on a computer for dynamic detail-in-context display on an electronic display surface such as a monitor. In the case of two dimensional data, EPS is typically characterized by magnification of areas of an
20 image where detail is desired **233**, in combination with compression of a restricted range of areas of the remaining information (i.e. the context) **234**, the end result typically giving the appearance of a lens **230** having been applied to the display surface. The areas of the lens **230** where compression occurs may be referred to as the "shoulder" **234** of the lens **230**. The area of the representation transformed by the lens may be referred to as the "lensed area". The lensed area
25 thus includes the focal region and the shoulder. To reiterate, the source image or representation to be viewed is located in the basal plane **210**. Magnification **233** and compression **234** are achieved through elevating elements of the source image relative to the basal plane **210**, and then projecting the resultant distorted surface onto the reference view plane **201**. EPS performs detail-in-context presentation of n-dimensional data through the use of a procedure wherein the data is
30 mapped into a region in an (n+1) dimensional space, manipulated through perspective

projections in the (n+1) dimensional space, and then finally transformed back into n-dimensional space for presentation. EPS has numerous advantages over conventional zoom, pan, and scroll technologies, including the capability of preserving the visibility of information outside **234** the local region of interest **233**.

5 For example, and referring to FIGS. 1 and 2, in two dimensions, EPS can be implemented through the projection of an image onto a reference plane **201** in the following manner. The source image or representation is located on a basal plane **210**, and those regions of interest **233** of the image for which magnification is desired are elevated so as to move them closer to a reference plane situated between the reference viewpoint **240** and the reference view plane **201**.
10 Magnification of the focal region **233** closest to the RVP **201** varies inversely with distance from the RVP **201**. As shown in FIGS. 1 and 2, compression of regions **234** outside the focal region **233** is a function of both distance from the RVP **201**, and the gradient of the function describing the vertical distance from the RVP **201** with respect to horizontal distance from the focal region **233**. The resultant combination of magnification **233** and compression **234** of the image as seen
15 from the reference viewpoint **240** results in a lens-like effect similar to that of a magnifying glass applied to the image. Hence, the various functions used to vary the magnification and compression of the source image via vertical displacement from the basal plane **210** are described as lenses, lens types, or lens functions. Lens functions that describe basic lens types with point and circular focal regions, as well as certain more complex lenses and advanced
20 capabilities such as folding, have previously been described by Carpendale.

System. FIG. 3 is a block diagram of a data processing system **300** adapted to implement an embodiment of the invention. The data processing system is suitable for implementing EPS technology, for displaying detail-in-context presentations of representations, and for performing drag and drop ("DAD") operations in conjunction with a detail-in-context graphical user
25 interface ("GUI") **400**, as described below. The data processing system **300** includes an input device **310**, a central processing unit or CPU **320**, memory **330**, and a display **340**. The input device **310** may include a keyboard, mouse, trackball, or similar device. The CPU **320** may include dedicated coprocessors and memory devices. The memory **330** may include RAM, ROM, databases, or disk devices. And, the display **340** may include a computer screen, terminal
30 device, or a hardcopy producing output device such as a printer or plotter. The data processing

system 300 has stored therein data representing sequences of instructions which when executed cause the method described herein to be performed. Of course, the data processing system 300 may contain additional software and hardware a description of which is not necessary for understanding the invention.

5 *GUI with Lens Control Elements.* As mentioned, detail-in-context presentations of data using techniques such as pliable surfaces, as described by Carpendale, are useful in presenting large amounts of information on limited-size display surfaces. Detail-in-context views allow magnification of a particular region-of-interest (the “focal region”) 233 in a data presentation while preserving visibility of the surrounding information 210. In the following, a GUI 400 is
10 described having lens control elements that can be implemented in software and applied to DAD operations and to the control of detail-in-context data presentations. The software can be loaded into and run by the data processing system 300 of FIG. 3.

FIG. 4 is a partial screen capture illustrating a GUI 400 having lens control elements for user interaction with detail-in-context data presentations in accordance with an embodiment of the
15 invention. Detail-in-context data presentations are characterized by magnification of areas of an image where detail is desired, in combination with compression of a restricted range of areas of the remaining information (i.e. the context), the end result typically giving the appearance of a lens having been applied to the display screen surface. This lens 410 includes a “focal region” 420 having high magnification, a surrounding “shoulder region” 430 where information is
20 typically visibly compressed, and a “base” 412 surrounding the shoulder region 430 and defining the extent of the lens 410. In FIG. 4, the lens 410 is shown with a circular shaped base 412 (or outline) and with a focal region 420 lying near the center of the lens 410. However, the lens 410 and focal region 420 may have any desired shape. For example, in FIG. 5, the lens 410 has a pyramid shape with a flat top 420 and trapezoidal shoulders 430. As mentioned above, the base
25 of the lens 412 may be coextensive with the focal region 420.

In general, the GUI 400 has lens control elements that, in combination, provide for the interactive control of the lens 410. The effective control of the characteristics of the lens 410 by a user (i.e. dynamic interaction with a detail-in-context lens) is advantageous. At any given time, one or more of these lens control elements may be made visible to the user on the display surface

340 by appearing as overlay icons on the lens 410. Interaction with each element is performed via the motion of an input or pointing device 310 (e.g. mouse), with the motion resulting in an appropriate change in the corresponding lens characteristic. As will be described, selection of which lens control element is actively controlled by the motion of the pointing device 310 at any
5 given time is determined by the proximity of the icon representing the pointing device 310 (e.g. cursor) on the display surface 340 to the appropriate component of the lens 410. For example, “dragging” of the pointing device at the periphery of the bounding rectangle of the lens base 412 causes a corresponding change in the size of the lens 410 (i.e. “resizing”). Thus, the GUI 400 provides the user with a visual representation of which lens control element is being adjusted
10 through the display of one or more corresponding icons.

For ease of understanding, the following discussion will be in the context of using a two-dimensional pointing device 310 that is a mouse, but it will be understood that the invention may be practiced with other 2-D or 3-D (or even greater numbers of dimensions) pointing devices including a trackball and keyboard.

15 A mouse 310 controls the position of a cursor icon 401 that is displayed on the display screen 340. The cursor 401 is moved by moving the mouse 310 over a flat surface, such as the top of a desk, in the desired direction of movement of the cursor 401. Thus, the two-dimensional movement of the mouse 310 on the flat surface translates into a corresponding two-dimensional movement of the cursor 401 on the display screen 340.

20 A mouse 310 typically has one or more finger actuated control buttons (i.e. mouse buttons). While the mouse buttons can be used for different functions such as selecting a menu option pointed at by the cursor 401, the disclosed invention may use a single mouse button to “select” a lens 410 and to trace the movement of the cursor 401 along a desired path. Specifically, to select a lens 410, the cursor 401 is first located within the extent of the lens 410. In other words, the
25 cursor 401 is “pointed” at the lens 410. Next, the mouse button is depressed and released. That is, the mouse button is “clicked”. Selection is thus a point and click operation. To trace the movement of the cursor 401, the cursor 401 is located at the desired starting location, the mouse button is depressed to signal the computer 320 to activate a lens control element, and the mouse 310 is moved while maintaining the button depressed. After the desired path has been traced, the

mouse button is released. This procedure is often referred to as “clicking” and “dragging” (i.e. a click and drag operation). It will be understood that a predetermined key on a keyboard **310** could also be used to activate a mouse click or drag. In the following, the term “clicking” will refer to the depression of a mouse button indicating a selection by the user and the term “dragging” will refer to the subsequent motion of the mouse **310** and cursor **401** without the release of the mouse button.

The GUI **400** may include the following lens control elements: move, pickup, resize base, resize focus, fold, magnify, and scoop. Each of these lens control elements has at least one lens control icon or alternate cursor icon associated with it. In general, when a lens **410** is selected by a user through a point and click operation, the following lens control icons may be displayed over the lens **410**: pickup icon **450**, base outline icon **412**, base bounding rectangle icon **411**, focal region bounding rectangle icon **421**, handle icons **481**, **482**, **491**, **492** (see FIG. 5), magnify slide bar icon **440**, and scoop slide bar icon **540** (see FIG. 5). Typically, these icons are displayed simultaneously after selection of the lens **410**. In addition, when the cursor **401** is located within the extent of a selected lens **410**, an alternate cursor icon **460**, **470**, **480**, **490** may be displayed over the lens **410** to replace the cursor **401** or may be displayed in combination with the cursor **401**. These lens control elements, corresponding icons, and their effects on the characteristics of a lens **410** are described below with reference to FIG. 4.

In general, when a lens **410** is selected by a point and click operation, bounding rectangle icons **411**, **421** are displayed surrounding the base **412** and focal region **420** of the selected lens **410** to indicate that the lens **410** has been selected. With respect to the bounding rectangles **411**, **421** one might view them as glass windows enclosing the lens base **412** and focal region **420**, respectively. The bounding rectangles **411**, **421** include handle icons **481**, **482**, **491**, **492** allowing for direct manipulation of the enclosed base **412** and focal region **420** as will be explained below. Thus, the bounding rectangles **411**, **421** not only inform the user that the lens **410** has been selected, but also provide the user with indications as to what manipulation operations might be possible for the selected lens **410** though use of the displayed handles **481**, **482**, **491**, **492**. Note that it is well within the scope of the present invention to provide a bounding region having a shape other than generally rectangular. Such a bounding region could be of any of a great

number of shapes including oblong, oval, ovoid, conical, cubic, cylindrical, polyhedral, spherical, etc.

Moreover, the cursor **401** provides a visual cue indicating the nature of an available lens control element. As such, the cursor **401** will generally change in form by simply pointing to a different lens control icon **450, 412, 411, 421, 481, 482, 491, 492, 440, 540**. For example, when resizing the base **412** of a lens **410** using a corner handle **491**, the cursor **401** will change form to a resize icon **490** once it is pointed at (i.e. positioned over) the corner handle **491**. The cursor **401** will remain in the form of the resize icon **490** until the cursor **401** has been moved away from the corner handle **491**.

Move. Lateral movement of a lens **410** is provided by the move lens control element of the GUI **400**. This functionality is accomplished by the user first selecting the lens **410** through a point and click operation. Then, the user points to a point within the lens **410** that is other than a point lying on a lens control icon **450, 412, 411, 421, 481, 482, 491, 492, 440, 540**. When the cursor **401** is so located, a move icon **460** is displayed over the lens **410** to replace the cursor **401** or may be displayed in combination with the cursor **401**. The move icon **460** not only informs the user that the lens **410** may be moved, but also provides the user with indications as to what movement operations are possible for the selected lens **410**. For example, the move icon **460** may include arrowheads indicating up, down, left, and right motion. Next, the lens **410** is moved by a click and drag operation in which the user clicks and drags the lens **410** to the desired position on the screen **340** and then releases the mouse button **310**. The lens **410** is locked in its new position until a further pickup and move operation is performed.

Pickup. Lateral movement of a lens **410** is also provided by the pickup lens control element of the GUI. This functionality is accomplished by the user first selecting the lens **410** through a point and click operation. As mentioned above, when the lens **410** is selected a pickup icon **450** is displayed over the lens **410** at the cursor location (e.g. near the centre of the lens **410**). Typically, the pickup icon **450** will be a crosshairs. In addition, a base outline **412** is displayed over the lens **410** representing the base **412** of the lens **410**. The crosshairs **450** and lens outline **412** not only inform the user that the lens has been selected, but also provides the user with an indication as to the pickup operation that is possible for the selected lens **410**. Next, the user

points at the crosshairs 450 with the cursor 401. Then, the lens outline 412 is moved by a click and drag operation in which the user clicks and drags the crosshairs 450 to the desired position on the screen 340 and then releases the mouse button 310. The full lens 410 is then moved to the new position and is locked there until a further pickup operation is performed. In contrast to the move operation described above, with the pickup operation, it is the outline 412 of the lens 410 that the user repositions rather than the full lens 410.

Resize Base. Resizing of the base 412 (or outline) of a lens 410 is provided by the resize base lens control element of the GUI. After the lens 410 is selected, a bounding rectangle icon 411 is displayed surrounding the base 412. The bounding rectangle 411 includes handles 491. These handles 491 can be used to stretch the base 412 taller or shorter, wider or narrower, or proportionally larger or smaller. The corner handles 491 will keep the proportions the same while changing the size. The middle handles 492 (see FIG. 5) will make the base 412 taller or shorter, wider or narrower. Resizing the base 412 by the corner handles 491 will keep the base 412 in proportion. Resizing the base 412 by the middle handles 492 will change the proportions of the base 412. That is, the middle handles 492 change the aspect ratio of the base 412 (i.e. the ratio between the height and the width of the bounding rectangle 411 of the base 412). When a user points at a handle 491 with the cursor 401 a resize icon 490 may be displayed over the handle 491 to replace the cursor 401 or may be displayed in combination with the cursor 401. The resize icon 490 not only informs the user that the handle 491 may be selected, but also provides the user with indications as to the resizing operations that are possible with the selected handle. For example, the resize icon 490 for a corner handle 491 may include arrows indicating proportional resizing. The resize icon (not shown) for a middle handle 492 may include arrows indicating width resizing or height resizing. After pointing at the desired handle 491, 492, the user would click and drag the handle 491, 492 until the desired shape and size for the base 412 is reached. Once the desired shape and size are reached, the user would release the mouse button 310. The base 412 of the lens 410 is then locked in its new size and shape until a further base resize operation is performed.

Resize Focus. Resizing of the focal region 420 of a lens 410 is provided by the resize focus lens control element of the GUI. After the lens 410 is selected, a bounding rectangle icon 421 is displayed surrounding the focal region 420. The bounding rectangle 421 includes handles 481,

482. These handles 481, 482 can be used to stretch the focal region 420 taller or shorter, wider or narrower, or proportionally larger or smaller. The corner handles 481 will keep the proportions the same while changing the size. The middle handles 482 will make the focal region 420 taller or shorter, wider or narrower. Resizing the focal region 420 by the corner handles 481 will keep the focal region 420 in proportion. Resizing the focal region 420 by the middle handles 482 will change the proportions of the focal region 420. That is, the middle handles 482 change the aspect ratio of the focal region 420 (i.e. the ratio between the height and the width of the bounding rectangle 421 of the focal region 420). When a user points at a handle 481, 482 with the cursor 401 a resize icon 480 may be displayed over the handle 481, 482 to replace the cursor 401 or may be displayed in combination with the cursor 401. The resize icon 480 not only informs the user that a handle 481, 482 may be selected, but also provides the user with indications as to the resizing operations that are possible with the selected handle. For example, the resize icon 480 for a corner handle 481 may include arrows indicating proportional resizing. The resize icon 480 for a middle handle 482 may include arrows indicating width resizing or height resizing. After pointing at the desired handle 481, 482, the user would click and drag the handle 481, 482 until the desired shape and size for the focal region 420 is reached. Once the desired shape and size are reached, the user would release the mouse button 310. The focal region 420 is then locked in its new size and shape until a further focus resize operation is performed.

Fold. Folding of the focal region 420 of a lens 410 is provided by the fold control element of the GUI. In general, control of the degree and direction of folding (i.e. skewing of the viewer aligned vector 231 as described by Carpendale) is accomplished by a click and drag operation on a point 471, other than a handle 481, 482, on the bounding rectangle 421 surrounding the focal region 420. The direction of folding is determined by the direction in which the point 471 is dragged. The degree of folding is determined by the magnitude of the translation of the cursor 401 during the drag. In general, the direction and degree of folding corresponds to the relative displacement of the focus 420 with respect to the lens base 410. In other words, and referring to FIG. 2, the direction and degree of folding corresponds to the displacement of the point FP 233 relative to the point FPo 232, where the vector joining the points FPo 232 and FP 233 defines the viewer aligned vector 231. In particular, after the lens 410 is selected, a bounding rectangle icon 421 is displayed surrounding the focal region 420. The bounding rectangle 421 includes handles 481,

482. When a user points at a point 471, other than a handle 481, 482, on the bounding rectangle 421 surrounding the focal region 420 with the cursor 401, a fold icon 470 may be displayed over the point 471 to replace the cursor 401 or may be displayed in combination with the cursor 401. The fold icon 470 not only informs the user that a point 471 on the bounding rectangle 421 may be selected, but also provides the user with indications as to what fold operations are possible. For example, the fold icon 470 may include arrowheads indicating up, down, left, and right motion. By choosing a point 471, other than a handle 481, 482, on the bounding rectangle 421 a user may control the degree and direction of folding. To control the direction of folding, the user would click on the point 471 and drag in the desired direction of folding. To control the degree of folding, the user would drag to a greater or lesser degree in the desired direction of folding. Once the desired direction and degree of folding is reached, the user would release the mouse button 310. The lens 410 is then locked with the selected fold until a further fold operation is performed.

Magnify. Magnification of the lens 410 is provided by the magnify lens control element of the GUI. After the lens 410 is selected, the magnify control is presented to the user as a slide bar icon 440 near or adjacent to the lens 410 and typically to one side of the lens 410. Sliding the bar 441 of the slide bar 440 results in a proportional change in the magnification of the lens 410. The slide bar 440 not only informs the user that magnification of the lens 410 may be selected, but also provides the user with an indication as to what level of magnification is possible. The slide bar 440 includes a bar 441 that may be slid up and down, or left and right, to adjust and indicate the level of magnification. To control the level of magnification, the user would click on the bar 441 of the slide bar 440 and drag in the direction of desired magnification level. Once the desired level of magnification is reached, the user would release the mouse button 310. The lens 410 is then locked with the selected magnification until a further magnification operation is performed. In general, the focal region 420 is an area of the lens 410 having constant magnification (i.e. if the focal region is a plane). Again referring to FIGS. 1 and 2, magnification of the focal region 420, 233 varies inversely with the distance from the focal region 420, 233 to the reference view plane (RVP) 201. Magnification of areas lying in the shoulder region 430 of the lens 410 also varies inversely with their distance from the RVP 201. Thus, magnification of areas lying in the shoulder region 430 will range from unity at the base 412 to the level of magnification of the focal region 420.

Scoop. The concavity or "scoop" of the shoulder region 430 of the lens 410 is provided by the scoop lens control element of the GUI. After the lens 410 is selected, the scoop control is presented to the user as a slide bar icon 540 (see FIG. 5) near or adjacent to the lens 410 and typically below the lens 410. Sliding the bar 541 of the slide bar 540 results in a proportional
5 change in the concavity or scoop of the shoulder region 430 of the lens 410. The slide bar 540 not only informs the user that the shape of the shoulder region 430 of the lens 410 may be selected, but also provides the user with an indication as to what degree of shaping is possible. The slide bar 540 includes a bar 541 that may be slid left and right, or up and down, to adjust and indicate the degree of scooping. To control the degree of scooping, the user would click on the
10 bar 541 of the slide bar 540 and drag in the direction of desired scooping degree. Once the desired degree of scooping is reached, the user would release the mouse button 310. The lens 410 is then locked with the selected scoop until a further scooping operation is performed.

Icon Hiding. Advantageously, a user may choose to hide one or more lens control icons 450, 412, 411, 421, 481, 482, 491, 492, 440, 540 shown in FIGS. 4 and 5 from view so as not to
15 impede the user's view of the image within the lens 410. This may be helpful, for example, during a move or drag and drop operation. A user may select this option through means such as a menu or lens property dialog box.

GUI with Lens Control Elements and Attached Toolbar. Detail-in-context lenses may be used in a variety of applications. Using the GUI 400 described above, a user may change the manner in
20 which information is displayed or presented. For example, the user may change the shape of the lens 410 (e.g. from pyramid shaped to cone shaped). Detail-in-context lens may also be used for editing applications. For example, a user may change the colour of a pixel, or add a label to source data, using a detail-in-context lens as a selection device. Detail-in-context lens may be used for more complex editing applications such as DAD operations as will be described in more
25 detail below. Such detail-in-context lens applications or modes may be chosen by a user via keyboard commands, pull-down menu, or toolbar.

FIG. 5 is a screen capture illustrating a GUI 500 having lens control elements and an attached horizontal toolbar 510 for user interaction with a detail-in-context data presentation 550 in accordance with an embodiment of the invention. In FIG. 5, the toolbar 510 is located above the

lens 410. The toolbar 510 includes a number of icons 561, 562, 563, 564, 565, 566 for selecting an application for the lens 410 and/or for providing related functions. In FIG. 5, the toolbar 510 includes a pointer icon 561 for selecting points in the presentation 550 using the lens 410, a hand tool icon 562 for selecting a view area for the presentation 550, a zoom tool icon 563 for zooming into or away from the region-of-interest 420 or presentation 550 (see the Applicant's co-pending Canadian Patent Application No. 2,350,342, which is incorporated herein by reference), a measuring tool icon 564 for initiating a measurement operation (see the Applicant's co-pending Canadian Patent Application Nos. 2,393,708 and 2,394,119, which are incorporated herein by reference), a help tool icon 565 for initiating a user help function as is known in the art, and a continuation arrow icon 566 for indicating the existence of and scrolling additional toolbar icons into view.

FIG. 6 is a screen capture illustrating a GUI 600 having lens control elements and an attached vertical toolbar 610 for user interaction with a detail-in-context data presentation 550 in accordance with an embodiment of the invention. In FIG. 6, the toolbar 610 is located at the side of the lens 410. Again, the toolbar 610 includes a number of icons 661, 662, 663, 664, 665, 666, 566 for selecting an application for the lens 410 and/or for providing related functions. The toolbar 610 includes a pyramid lens icon 661 for choosing a pyramid shaped lens 410, a circular based lens icon 662 for choosing a lens 410 with a circular base 412, a circular focus icon 663 for choosing a lens 410 with a circular shaped focus 420, a delete icon 664 for deleting a lens from the presentation 550, and the continuation arrow icon 566 for indicating the existence of and scrolling additional toolbar icons into view. Additional icons 665, 666 may be included for additional functions, as needed, or may be included as reduced-sized representations of the data or objects to be copied, cut, or placed.

FIG. 7 is a screen capture illustrating a GUI 700 having lens control elements and an attached corner toolbar 710 for user interaction with a detail-in-context data presentation 550 in accordance with an embodiment of the invention. In FIG. 7, the toolbar 710 is located at a corner of the lens 410. Again, the toolbar 710 includes a number of icons 661, 662, 663, 664, 566 for selecting an application for the lens 410 and/or for providing related functions. The toolbar 710 includes a pyramid lens icon 661 for choosing a pyramid shaped lens 410, a circular based lens icon 662 for choosing a lens 410 with a circular base 412, a circular focus icon 663 for choosing

a lens 410 with a circular shaped focus 420, a delete icon 664 for deleting a lens from the presentation 550, and the continuation arrow icon 566 for indicating the existence of and scrolling additional toolbar icons into view.

Advantageously, by attaching the toolbar 510, 610, 710 to the lens GUI 400, the controls available through the toolbar 510, 610, 710 are made more easily accessible to a user. As the lens 410 and GUI 500, 600, 700 move, the toolbar 510 610, 710 moves with them allowing the user easy access to alternate lens applications as the user homes-in on a region-of-interest 420 in a presentation 550. In this way, if the user decides to change lens applications, the toolbar 510, 610, 710 is exactly where the user requires it, that is, near the lens 410.

According to one embodiment, the toolbar 510, 610, 710 need not be visible at all times. An icon, for example the continuation arrow icon 566, may be used to toggle the visibility of the toolbar 510, 610, 710 on and off. Alternatively, the toolbar 510, 610, 710 may be transparent along with the rest of the GUI 500, 600, 700 as illustrated in FIGS. 5, 6, and 7. According to another embodiment, the toolbar 510, 610, 710 need not be docked or attached to the lens 410 at all times. Rather, an icon (not shown) on the toolbar 510, 610, 710 may be clicked to toggle the toolbar from a docked to a floating state. According to another embodiment, the toolbar 510, 610, 710 or its icons may be resized. For example, the toolbar icons 561, 562, 563, 564, 565, 566 may be presented at a larger size as the user directs the cursor 401 toward them. According to another embodiment, the position of the toolbar 510, 610, 710 may vary with the position of the lens 410 on the display screen 340. For example, if a presentation 550 has a lens 410 positioned at the top-left corner of the screen 340, then the toolbar 710 may be automatically presented at the bottom-right corner of the lens 410 as shown in FIG. 7. According to another embodiment, an icon (not shown) on the toolbar 510, 610, 710 may be clicked to toggle the location of the toolbar about the lens 410. According to another embodiment, the toolbar 510, 610, 710 may be manually or automatically resized. According to another embodiment, the toolbar icons may represent applications that are currently running. By clicking on a toolbar icon, the user is able to switch from a first application to another from within the first application. According to another embodiment, the toolbar icons may be used to indicate the status of applications that are currently running. For example, a printer icon 861 (see FIG. 8) may indicate that printing is in

progress. Another icon (not shown) may indicate that retrieving of high resolution data through the lens 410 is in progress.

FIG. 8 is a screen capture illustrating a GUI 800 having toolbar icons 561, 562, 563, 564, 565, 566, 661, 662, 664, 861, 862, 863, 864, 865, 866 placed over base and focus resize handle icons 481, 482, 491, 492 for user interaction with a detail-in-context data presentation 550 in accordance with an embodiment of the invention. The GUI 800 includes a number of toolbar icons for selecting an application for the lens 410 and/or for providing related functions. The toolbar icons include a printer icon 861 for selecting or indicating the status of a print application, a floppy disk icon 863 for selecting or indicating the status of a save application, redo/undo icons 846 for selecting redo and undo applications, a resize base icon 865 for selecting a predefined base resizing application, and a resize focus icon 866 for selecting a predefined focus resizing operation. An additional icon 862 may be included for an additional function, as needed, or may be included as a reduced-sized representation of the data or objects to be copied, cut, or placed. According to one embodiment, the toolbar icons may be distributed along the bounding rectangles 411, 421 of the base 412 and focus 420 of the lens 410 rather than being placed over the base and focus resize handle icons 481, 482, 491, 492. According to another embodiment, an icon (not shown) may be clicked to toggle the location of the toolbar icons from over the base and focus resize handle icons 481, 482, 491, 492 to a toolbar 510, 610, 710 located adjacent to the lens 410. Advantageously, by placing toolbar icons 561, 562, 563, 564, 565, 566, 661, 662, 664, 861, 862, 863, 864, 865, 866 over base and focus resize handle icons 481, 482, 491, 492, the visibility of the presentation 550 to the user may be improved for some applications. Again, other icons may be added to represent other functions or to represent data to be cut, copied, or placed.

Dragging and Dropping with Detail-In-Context Lenses. Now, in accordance with the present invention, detail-in-context data viewing techniques are applied to DAD operations in digital image presentations. Detail-in-context data viewing techniques allow a user to view multiple levels of detail or resolution on one display 340. The appearance of the data display or presentation is that of one or more virtual lens showing detail 233 within the context of a larger area view 210. In accordance with the present invention, detail-in-context lenses may be used to perform accurate DAD operations.

As mentioned above, a user typically interacts with a GUI by using a pointing device (e.g., a mouse) 310 to position a pointer or cursor 401 over an object and "clicking" on the object. FIG. 9 is a screen capture illustrating such an object 910 in an original image 900 in accordance with an embodiment of the invention. Thus, a drag and drop ("DAD") operation may be initiated by selection from a toolbar 510, 610, 710, 810 or by selecting an object 910 within an original image 900. The pointing device (e.g. mouse) 310 is used to select an object 910 (e.g., text, icons, graphical objects, etc.) under a cursor 401 and then "drag" the selected object 910 to a different location or orientation on a display screen 340. The user may then "drop" or release the object 910 at a desired new location or orientation indicated by the position of the cursor 401. Selecting may be initiated by holding down a button associated with the pointing device (e.g., a mouse button) 310 and gesturing with the pointing device 310 to indicate the bounds of the object 910 to be selected (as in text selection), or simply by "clicking" on the object 910 under the cursor 401 (as in graphical image or icon selection). Selection may be indicated by a change in the visual display of the selected object 910 (e.g., by using reverse video, displaying a frame around the object, displaying selection handles around the object, etc.). In FIG. 9, the selection of the object 910 is indicated by a dashed line 920 bounding the object 910.

Once an object 910 is selected, a lens 410 is attached to the object 910. Any point on the selected object 910 may be chosen to be in the centre of the lens focus 420. FIG. 10 is a screen capture illustrating the attachment of a lens 410 to a selected object 910 to produce a detail-in-context presentation 905 in accordance with an embodiment of the invention. In FIG. 10, the centre of the focus 420 of the lens 410 is attached at any point 930 (e.g. an end point) of the object 910. The lens 410 may be configured using its associated GUI 400 in the manner described above. That is, the shape, size, magnification, scoop, and fold for the lens 410 may all be carefully tuned for the selected object 910. The lens 410 may be configured before attachment to the selected object 910 or after attachment. In addition, the lens 410 may be displayed before the object 910 is selected to aid in the selection of the object 910.

FIG. 11 is a screen capture illustrating a drop and drag operation for a detail-in-context presentation 905 in accordance with an embodiment of the invention. Having selected and attached a lens 410 to the object 910, the object 910 may now be dragged to its new location 940. Dragging may be a separate step distinct from selection and attachment, and may be initiated by

clicking on the selected object 910 and depressing a mouse 310 control button. The object 910 is then dragged from its original position 930 to its new position 940 while holding the control button down. As the object 910 moves, the lens 410 moves with it. Alternatively, the lens 410 may be thought of as carrying the object 910, that is, the object 910 may be attached to the lens 410 such that as the lens 410 moves, the object 910 moves with it. In an alternative embodiment, initiating dragging also selects the object 910 under the cursor 401 and attaches a lens 410 to it. In another embodiment, selecting the object 910 attaches a lens 410 and initiates dragging. The DAD operation is completed by dropping the selected object 910 at its new location 940. That is, releasing the mouse button when a selected point on the object 930 is aligned with a desired point 940 at the new location.

Advantageously, since the magnification at the focus 420 of the lens 410 is greater than that at the base of the lens 410, dragging the lens 410 with the selected object 910 makes it easier for a user to align a point 930 on the selected object 910 with a point 940 at the new location for the object in the presentation 905. For example, the magnification in the focus 420 may be set to pixel level resolution using the magnification slide bar icon 440. As the lens 410 with its selected object 910 moves to the new location 940, the region around the new location 940 is magnified to the same high resolution. As a result, the accuracy of aligning the point 930 on the selected object 910 to a desired point 940 at the new location is improved. In addition, the user is assisted throughout this DAD operation by being able to observe the detail in the lens focus 420 in the context of the surrounding presentation 900. Finally, once the points 930, 940 are aligned, the object 910 may be dropped from the lens 410 into its new position.

In operation, the data processing system 300 employs EPS techniques with an input device 310 and GUI 500, 600, 700, 800 for selecting an object 910 and points 930, 940 to perform a DAD operation for display to a user on a display screen 340. Data representing an original image 900 or representation is received by the CPU 320 of the data processing system 300. Using EPS techniques, the CPU 320 processes the data in accordance with instructions received from the user via an input device 310 and GUI 500, 600, 700, 800 to produce a detail-in-context presentation 905. The presentation 905 is presented to the user on a display screen 340. It will be understood that the CPU 320 may apply a transformation to the shoulder region 430 surrounding the region-of-interest 420 to affect blending or folding in accordance with EPS technology. For

example, the transformation may map the region-of-interest **420** and/or shoulder region **430** to a predefined lens surface, defined by a transformation or distortion function and having a variety of shapes, using EPS techniques. Or, the lens **410** may be simply coextensive with the region-of-interest **420**. (Blending and folding of lenses in detail-in-context presentations are described in
5 United States Patent Application Publication No. 2002/0044154 which is incorporated herein by reference.)

The lens control elements of the GUI **500, 600, 700, 800** are adjusted by the user via an input device **310** to control the characteristics of the lens **410** in the detail-in-context presentation **905**. Using an input device **310** such as a mouse, a user adjusts parameters of the lens **410** using icons
10 and scroll bars of the GUI **500, 600, 700, 800** that are displayed over the lens on the display screen **340**. The user may also adjust parameters of the image of the full scene **905**. Signals representing input device **310** movements and selections are transmitted to the CPU **320** of the data processing system **300** where they are translated into instructions for lens control.

In FIG. 9, the dashed line **920** indicates the object **910** selected for the DAD operation. In FIG.
15 10, by moving the lens **410** on the display screen **340** with the lens GUI **500, 600, 700, 800**, the user can locate the focus **420** of the lens **410** over a selected point **930** on the object **910** in the presentation **905**. In FIG. 11, observing the points **930, 940** within the focus **420** of the lens **410** as the user drags the object **910**, the user can decide whether or not the current position of the object **910** is desirable. If the user is satisfied with the current position, the user may drop the
20 object **910**. If the user is dissatisfied with the current position of the object **910**, then the object may be dragged to a new position. Advantageously, by using a detail-in-context lens **410** to select an object **910** or points **930, 940** defining a DAD operation, a user can view a large area **905** (i.e. outside the lens **410**) while focusing in on a smaller area **420** (i.e. inside the focal region **420** of the lens **410**) surrounding the selected object **910** or points **930, 940**. This makes it
25 possible for a user to perform an accurate DAD operation without losing visibility or context of the portion of the original image surrounding the selected object **910**.

Moreover, the lens **410** may be added to the presentation **900** before or after the object **910** is selected. That is, the user may first add a lens **410** to a presentation **900** or the user may move a pre-existing lens into place at, say, a selected point **930** on an object **910**. The lens **410** may be

introduced to the original image 900 to form the presentation 905 through the use of a pull-down menu selection, tool bar icon, etc. The DAD operation may then be activated using a toolbar selection or with a double click on the selected object 910. Now, as the select object 910 is dragged to its new location or point 940, the lens 410 is presented over and moves with the selected point 930 on the object 910. Again, this facilitates the accurate selection of the new position or point 940 defining the DAD operation.

The object 910 may consist of raster-based or vector-based data. In the case of vector-based data, a vector object 910 is attached to the lens 410 and may be aligned with other vector or raster data. The object 910 may also consist of text data which may be attached to the lens 410 and dragged to a new location in the presentation 905. Other objects 910 such as icons and 3-D objects may also be attached and dragged with the lens 410. For example, an icon representing a file or an application may be attached to the lens 410 and then dragged to the recycle bin for disposal. Or, a 3-D object such as a chair may be carried by the lens 410 and moved to a new location 940.

A number of pre-configured lenses 410 with or without attached objects 910 may be saved in the memory 330 of the system 300 for subsequent use. These lenses and objects may be saved in a general toolbar, in a lens toolbar 510, 610, 710, 810, or as a list of bookmarks in a pull-down menu and may be subsequently recalled and pasted into a presentation 905. In addition, pre-configured lenses 410 may be assigned names by a user. According to one embodiment, a lens 410 may be saved with more than one object 910 attached to it. In this embodiment, when the lens is moved, all of the attached objects move with it.

As described in the Applicant's co-pending Canadian Patent Application Nos. 2,393,708 and 2,394,119, referred to above, detail-in-context lens may be used for cropping an original image. Similarly, and in accordance with an embodiment of the present invention, the shape of a lens 410 applied to an original image 900 may be used to define a selection or "cut" from the original image. Lenses may be formed as squares, circles, or other shapes and these may be modified on the fly using the GUIs described above to form new shapes. A newly shaped lens may then be used as a "cookie cutter" or copier to cut, move (i.e. drag and drop as described above), and paste objects into a current presentation 905 or a new presentation. After performing a lens shaped cut,

the lens may be extended out beyond the bounds of the cut area to allow improved detail-in-context viewing and DAD operation. Moreover, if the original image includes multiple layers or is three-dimensional, then the cut may also include data from the different layers. That is, the cut may be multi-layer or multi-dimensional. In addition, the lens GUI may include a cut depth control slide bar icon or the like for specifying cut depth.

The present invention may be used in photo kiosk applications. In general, a photo kiosk is a specialized workstation connected to high quality printers for processing and printing digital photographic images, typically for a fee paid by the user. Photo kiosks typically have touch-sensitive screens ("touchscreens") for user input. The GUIs described above may be advantageously used in photo kiosks to facilitate user editing of digital images. For example, the lens extent handles 491, 492 and focus handles 481, 482 can be used to select the region or regions of a displayed photo which are to be printed or otherwise processed, and then the attached toolbar 510, 610, 710, 810 can be used to select a processing or printing operation to be performed. In one embodiment, the lens extent and focus handles 491, 491, 481, 482 can be overlaid with icons representing the status of a selected operation (e.g. printing, copying, or other processing of the image or of a part of the image). Moreover, the DAD operations described above can be used for adding images (e.g. flowers, hearts, text, background images, "Clipart", etc.) to an original image with enhanced placement accuracy.

Method. FIG. 12 is a flow chart 1200 illustrating a method for positioning a selected object 910 in a computer generated original image 900 on a display 340 in accordance with an embodiment of the invention. At step 1201, the method starts.

At step 1202, the original image 900 is distorted to produce a distorted region 410 for the object 910. This step of distorting may further include the steps of: creating a lens surface for the distorted region 410; and, transforming the original image 900 by applying a distortion function defining the lens surface to the original image 900. The step of creating may further include the step of displaying a GUI 400, 500, 600, 700, 800 over the distorted region 410 for adjusting the lens surface.

At step 1203, the object 910 and the distorted region 410 are dragged to a desired position 940.

At step 1204, the object 910 is dropped at the desired position 940. By using the distorted region 410, the object 910 is accurately positioned.

At step 1205, the method ends.

Data Carrier Product. The sequences of instructions which when executed cause the method described herein to be performed by the exemplary data processing system of FIG. 3 can be contained in a data carrier product according to one embodiment of the invention. This data carrier product can be loaded into and run by the exemplary data processing system of FIG. 3.

Computer Software Product. The sequences of instructions which when executed cause the method described herein to be performed by the exemplary data processing system of FIG. 3 can be contained in a computer software product according to one embodiment of the invention. This computer software product can be loaded into and run by the exemplary data processing system of FIG. 3.

Integrated Circuit Product. The sequences of instructions which when executed cause the method described herein to be performed by the exemplary data processing system of FIG. 3 can be contained in an integrated circuit product including a coprocessor or memory according to one embodiment of the invention. This integrated circuit product can be installed in the exemplary data processing system of FIG. 3.

Although preferred embodiments of the invention have been described herein, it will be understood by those skilled in the art that variations may be made thereto without departing from the spirit of the invention or the scope of the appended claims.